The Nexus Among Foreign Direct Investment, Economic Growth And Carbon Emissions: Evidence From India

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Abstract: In this study, an attempt has been made to analyse the nature of relationship among the variables of FDI inflows, economic growth and carbon emissions in the context of India. This study employs Dynamic Ordinary Least Squares (DOLS), which treats the endogeneity problem and also the estimators are adjusted for serial correlation. The findings of this study indicate that both FDI inflows and GDP per capita have a significant non-linear positive relationship with CO2 emissions. In addition, this study also supports the existence of pollution heaven hypothesis for this region.

Keywords: Carbon Emission, Economic Growth, Environmental degradation, Environmental Kuznets Curve, FDI, Pollution Halo Hypothesis, Pollution Heaven Hypothesis

1. INTRODUCTION

The FDI inflows in India have been following an increasing trend during the last three decades in India. But often in existing literature, FDI inflows have been treated as being both beneficial and costly for the host nations. It is often argued that FDI inflows not only induces growth in the host country but also at the same time creates costs for the host nations through its impact on environment. Existing literature in the field of economic theory provides us many reasons to believe that FDI leads to improvement in the growth performance of the host country. However, there is no universal agreement on this issue: while some of the studies found positive and significant relationship; at the same time many of them found negative impacts of FDI inflows through the ways of environmental degradation which makes economic growth of a nation not sustainable for future generation. In the literature, it is argued that the apart from inducing growth, FDI inflows carry different types of benefit with itself; such as: capital transfers, technology transfers, knowledge transfers etc. but at the same time, the host countries have to reach a certain level of development before they are able to capture potential benefits associated with FDI. Otherwise the potential benefits will remain far from realized [1]. The other side of this study is concerned with the environmental aspect of foreign Investment. This is a very complicated issue like the FDI-Growth nexus. There is a highly celebrated consensus that FDI inflows generally tend to come to those countries that have relatively less environmental regulations. But at the same time one can also argue for favourable impacts of FDI on environment. This is because; income growth may also have a favourable effect in long run on the environment by changing the demand towards cleaner goods. The lower demand in turn will lead to lower production of pollution-intensive goods.

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In view of such controversy on this issue, an attempt has been made in this study to analyse the nature of impact of economic growth and FDI inflows on carbon emissions especially in the context of India for the period 1980-2018. The analysis of this relationship is indeed a matter of great importance as it is often alleged in the existing literature that developing countries attract FDI inflows by relaxing environmental regulations. In this study CO2 emission is taken as a proxy of environmental degradation. It is undoubtedly true that the consideration of only carbon emission as a proxy of environmental degradation will simply understate the true scenario. But conceptually it will not be accurate to combine the different types of pollution and then to relate the aggregate measure to FDI inflows or economic growth [1]. Moreover, due to the non-availability of data on local air pollutants (such as SO2) for sufficiently longer time periods, only the variables of FDI inflows, CO2 emissions, energy use and real GDP per capita have been used in this study.

2. REVIEW OF LITERATURE AND RESEARCH GAP

In general the studies that concentrated upon the relationship among the variables of FDI inflows, CO2 emissions, energy consumption and GDP per capita can be divided into three broad schools. The first school basically consists of the studies that empirically tested the validity of Environmental Kuznet Curve (EKC). The second school consists of studies that concentrated on the relationship between energy use and CO2 emissions and the third school mainly related with the studies of empirical investigations involving FDI inflows and CO2 emissions. In a panel study on BRIC countries for the period of 1980-2007, Pao and Tsai (2011) found the existence of EKC for the group of countries. Moreover, the study also showed that FDI inflows did not have any impact on CO2 emissions unlike the energy consumption. Likewise, Seker et.al (2015) tried to study the causality between FDI, GDP and energy consumption with CO2 emissions in Turkey for the period 1974-2010. The findings of this study supported the existence of EKC curve for both short run and in long run in Turkey. Moreover, the results of ARDL model in this

analysis indicated that the impact of FDI on CO2 emission is positive but its magnitude is relatively small compared to impact of GDP and energy consumption in CO2 emissions. Apart from Turkey and BRIC countries; the validity of EKC in the Asia region was confirmed by a panel study made by Hang To et.al (2019). This analysis argued that FDI leads to emissions initially but also reduces emissions at later stage. Similarly the Oil consumption is also supposed to have a positive and significant impact on emissions in the Asian region. However, some of the major studies refuted the existence of EKC in their analysis. In a study on ASEAN countries, Narayan and Narayan (2010) nullified the existence of EKC for the ASEAN countries but it showed the existence of long run relationship between income and CO2 emissions. Besides the empirical study on the existence of EKC; some studies also tried to incorporate the variables of FDI inflows and Energy use in their respective analysis. For instance, Hoffmann et.al (2005) tried to analyse the causality between FDI and environmental pollution for a group of 112 countries with time period spanning from 15 to 28 years; i.e., 1971-1999. The results of this study indicated that in case of low income in countries, CO2 emission granger cause FDI inflows; while in case of middle income countries, FDI inflows Granger cause CO2 emission. But interestingly no Granger causality found between FDI and CO2 emission in the group of high income countries. Similarly in the context of Malaysia; a significant influence of FDI inflows on economic growth and environmental degradation in the short run was found in the study of Chew-Ging L (2005). Moreover, in a panel study over India and China, Baek and Koo (2008) found a unidirectional causality running from FDI to economic growth and environment in India and china for the period 1978-2000 and 1980-2002 respectively. In this study, it is also found that FDI inflow had a positive role (both short run and long run) in inducing economic growth in both the countries while it had negative impact on environmental quality. While in a study in the context of India, Acharyya J (2009) found that the FDI inflow had long run positive impact on both GDP growth and Co2 emissions of India. Cole et.al (2009) attempted to study the relationship among FDI, economic growth and environmental pollution for the period 2001-04 by taking into account 112 cities of China. The study found that domestic firms had the strongest detrimental effect on industrial emissions. But Chinese sourced firms had moderate detrimental effect on water pollution but insignificant impact on air pollution. With the help of STRIPAT model Zhang and Zhou (2016) attempted to study the impact of FDI on CO2 emission in China from 1995-2010 and found that FDI leads to reduction in CO2 emission in China across different regions; supporting the existence of the pollution halo hypothesis. Moreover, Lee J (2013) investigated the role of FDI in CO2 emissions, clean energy use and economic growth with the panel data of 19 nations of G20 for the period of 1971 to 2009. The results of fixed effects model indicates that FDI has a significant and positive impact in economic growth but it plays insignificant role in CO2 emissions. Similarly it is also found that economic growth has negative impact on CO2 emission but FDI seems to play no role in clean energy use in the group of G20 countries. Shahbaz et. al (2015) tried to analyse the impacts of foreign investment on environment degradation for a panel of low, medium and high income countries by including economic growth and energy consumption in the model under the analysis. Their findings also approved the existence of environmental Kuznets curve and pollution heaven hypothesis along with the bi-directional causality between co2 emissions and foreign direct investment. By having a brief review it is quite apparent that the relationship between economic growth and CO2 emissions has been a major issue of debate among the scholars; while the inclusion of FDI and energy consumption in to this relationship is quite a recent one. Although there has been a plethora of studies on this issue; but inclusion of FDI inflows in this relationship especially in the context of India is quite limited in the existing literature. Moreover; in most of time series analysis, OLS is used; but the estimators given by OLS is often proved to be biased. To overcome this drawback the estimation through DOLS is used in this paper which uses lead and lags of variables to overcome the problem of autocorrelation and endogeneity.

3. OBJECTIVES AND METHODOLOGY

The following are the major objectives of this study:

1. To analyse the impact of Foreign Direct Investment and Economic Growth on Carbon emission in the context of India
2. To analyse the nature of relationship among the variables of FDI inflows, Real GDP Per capita and CO2 emission in India.

3.1 Data Sources

This study uses secondary data for India for the time period 1980-2017. In line with the objectives mentioned above, the variables such as CO2 emissions, Energy use, Real GDP per capita (2010 US$) and Net FDI inflows has been used in this study. Table I shows the brief description and the sources of the variables used in the regression model.

Table I: *Description of the variables*

Variables	Description	Expected Sign	Sources
CO2 Emission	Metric tons per capita		World Bank Development Indicator, Knoema.com
GDP per capita	Constant 2010 US$	+/-	World Bank Development Indicator
Energy use	kg of oil equivalent per capita	+	World Bank Development Indicator
Net FDI inflows	Current US$	+/-	World Bank Development Indicator

The following table 2 represents summary statistics of the variables used in this analysis. As it can be from the summary that the variables were not normally distributed with their raw values; hence, all the variables are taken in logarithmic form to make them normally distributed.

Table II: *Summary of Statistics*

Variables	Mean	SD	Minimum	Maximum
FDI	12610951432.3243	16300000000	5640000	44500000000
CO2	1.023	0.434	0.4493	1.9400

GDP	945.73	478.75	422.90	2104.16
ENERGY	431.50	107.97	286.16	636.57

3.2 METHODOLOGY

In this study, the relationship between net FDI inflows, real GDP per capita, energy inflows and CO2 emissions has been estimated with the help of Dynamic Ordinary Least Square (DOLS) method as it takes in to account the problem of endogeneity and serial correlation in its estimation. Moreover the long run relationship among the variables has been checked through Johansen Co-integration method.

4. THEORETICAL BACKGROUND

Initially, in 1950s, Simon Kuznet propounded a hypothesis that as an economy grows, initially inequality increases but after a threshold, the trend of inequality tends to decrease with the economic growth. This hypothesis is popularly known as Kuznet Curve Hypothesis. But after some years, Kruger and Grossman applied the EKC hypothesis in the sphere of environment. This adaptation basically states that the process of economic growth and environmental degradation generally tends to follow an inverted U relationship. In other words, the Environmental Kuznet Curve hypothesis tells us that at the initial stage of growth of an economy, the improvement in the standards of living of people is generally achieved at the cost of environmental degradation but latter at high level of per capita income, the people becomes more concern about the health of the nature. So, after reaching a certain level of high per capita income a nation is supposed to sustain growth with greener technologies. Apart from the relationship between per capita income and environmental degradation; the impact of foreign investments (especially FDI) on environment is also a highly celebrated topic in the existing environmental literature. In fact, the existing environmental literature holds two contrasting hypotheses about the effect of FDI on environment. In one side, there are many studies that found that FDI is supposed to have positive environmental spill overs; because due to FDI, the less developed or underdeveloped economies get superior on greener technologies from the developed countries. This approach of FDI-Environment relationship is known as Pollution halo hypothesis. On the contrary, there are also a significant number of studies that found that FDI can also have harmful impact on environment. In those studies, it is argued that in the absence of skilled labour, capital and infrastructure stock; the developing countries use their relatively weaker environmental regulation as a trick to attract foreign investment. This is because, in advanced countries, the MNC s bears more costs for their polluting industries; as a result they find it profitable to shift their polluting industries to developing countries with lower levels of regulation. This approach of looking at the FDI-Environment relationship is popularly known as pollution heaven hypothesis in the environmental literature. The main reason behind this hypothesis is that strict environmental regulation increases costs; thus MNCs like to invest in the countries with weaker environmental regulation; ultimately leading to increasing environmental pollution. With this theoretical background, in this study an attempt has been made to study the relationship between FDI, economic growth and environmental degradation in the context of India. CO2 emission is taken as a proxy of environmental degradation in this study. Although it cannot represent the overall scenario of environmental degradation of a country; but it may exhibit the same characteristics of environmental degradation as it is a major factor responsible for environmental degradation in present day world. The general form of the model considered for analysis could be shown as below:

$$Y = f(X, X2, Z) \quad (1)$$

Where, Y represents indicator of environmental degradation, X represents level of income and Z represents vector of other explanatory variables. In the general form, the square term of income variable is included to check the validity of the shape of traditional EKC curve. In the specific form of (1), CO2 emission is used as proxy of environmental degradation as it has been very widely used in the existing literature. On the hand, Per capita real GDP (2010 $) is used to represent the income variable in the model. Moreover, Net FDI inflows to India, total energy consumption are also considered under the explanatory variable X. The regression model is proposed as follows:

$$LnCO2it=\alpha+\beta1LNGDPit+\beta2LNGDPit2+\beta3LNFDIit+\beta4LNFDIit2+ \beta5LNENGit+uit \quad (2)$$

In (2), all the variables are taken in logarithmic form. Here, CO2, GDP, FDI and ENG represent total CO2 emission, Real GDP Per Capita, Foreign Direct Investment and Total Energy Consumption respectively. The square terms of GDP and FDI inflows has been incorporated in the model to analyse their respective nature of relationship with CO2 emission.

5. TREND OF NET FDI INFLOWS AND CO2 EMISSION IN INDIA

Due to its various virtues, the developing countries often try to bring or attract foreign investment to their economy to stimulate the economic performance. Before liberalisation, the magnitude of FDI inflows was not so significant but its role along with its magnitude changed completely in post liberalisation period especially after 1992. As it can be seen from the following fig. 1, there has been exponential growth in FDI inflows in India over the time as compared with 1990s. But there were two sudden dips in net FDI inflows in India in the years of 2010 and 2012. The sudden fall in the FDI inflows in the year of 2010 may indirectly be attributed to the financial crisis of 2008. As per the report-"World Investment and Political Risks' published by the World Bank , the Multinational Companies were hit hard by the crisis and the several aspects such as weak global demand, global economic uncertainty etc. restricted their willingness and ability to invest in foreign countries. Similarly the slow economic growth and high inflation rate in India during 2012-13, badly affected the confidence of investors; as a result, the net FDI Inflows in India has fallen to 29 per cent in 2012. Since then; that is since 2012, the curve of FDI inflows has been maintaining an upward trend till 2018 with a slightest dip in 2017.

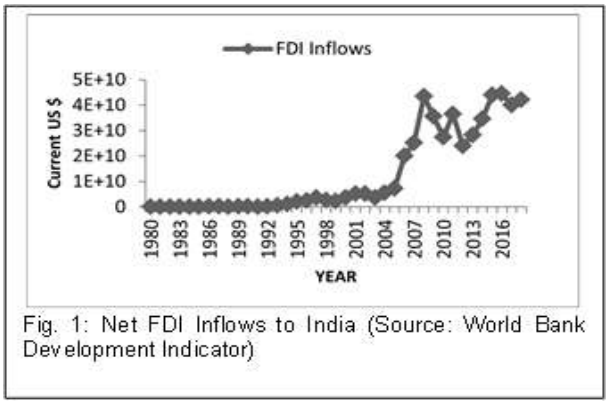

Fig. 1: Net FDI Inflows to India (Source: World Bank Development Indicator)

If the trend of FDI inflows in India is observed in a relative sense, more specifically as a percentage of GDP of India; it will be apparent that the growth of FDI inflows has been prominent since 1991 confirming the advantages of liberalisation. The trend of FDI inflows as a percentage of GDP is shown in the following fig. 2. As shown in fig. 2, there has been more or less exponential increase in FDI inflows till 2008 and then a serious continuous fall till 2010. However, after that the curve has been following an upward trend.

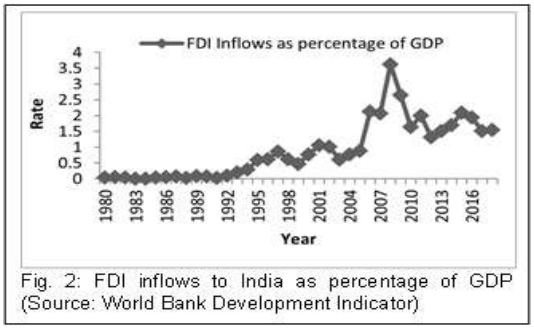

Fig. 2: FDI inflows to India as percentage of GDP (Source: World Bank Development Indicator)

As the data on CO2 emissions at industry level is not available at a compatible way for this study. This paper used CO2 emissions in India as a whole for the analysis during the period 1980-2018. This will help us to examine the impact of FDI inflows on CO2 emissions. The following fig. 3 reflects the growth of CO2 emissions in India since 1980. It is quite apparent from the following figure that the CO2 gas emission which is the largest constituent of greenhouse gases has been on an increasing trend since 1980.

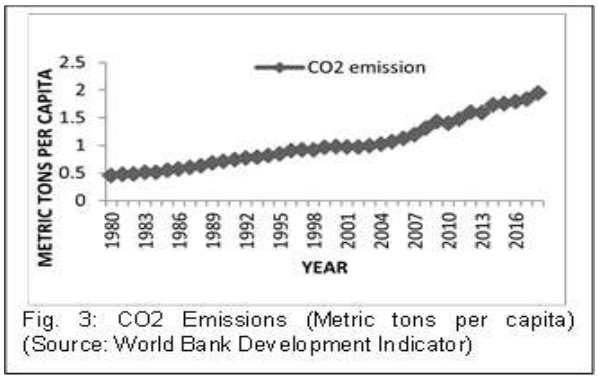

Fig. 3: CO2 Emissions (Metric tons per capita) (Source: World Bank Development Indicator)

6. ENERGY USE AND ECONOMIC GROWTH IN INDIA

Physical theory shows that energy is necessary for economic production which eventually results in economic growth. It is often seen that mainstream economics only emphasised on land; labour; capital and entrepreneurs as the principal factors of production and the energy resources are considered as intermediate products used in the production process. But in the existing literature, it has been proved that along with labour and capital; use of energy resources may also induced economic growth in a region.

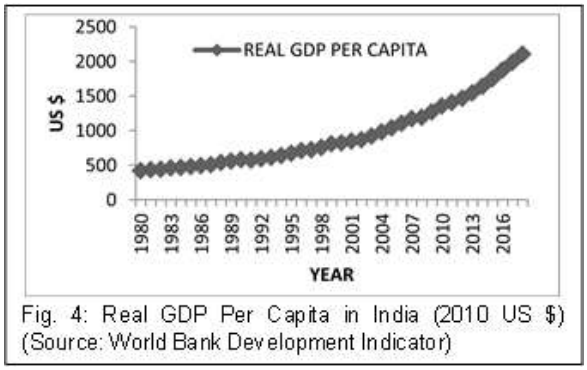

Fig. 4: Real GDP Per Capita in India (2010 US $) (Source: World Bank Development Indicator)

Therefore in this analysis, along with FDI, CO2 emissions; the variable of energy use is also included as it may have an indirect impact on CO2 emissions via its effect on production or economic growth. Fig. 4 presents the real GDP per capita for India during 1980-2010. It reveals the real GDP (at 2010 US $) has been showing an increasing trend in India over the years. A similar kind of positive upward trend can be seen from the fig. 5; which basically shows the amount of energy use in India during 1980-2018. Moreover, the Pearson correlation coefficient also indicates the possibility of higher correlation between these two variables. In fact it is very trivial that along with improvement in standard of living, rate of urbanisation and rate of industrialisation, the rate of energy use will naturally tend to increase.

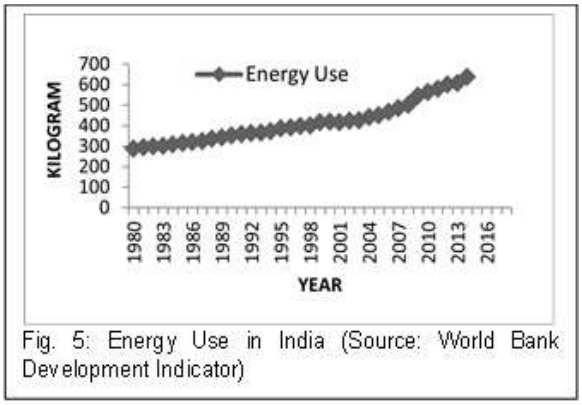

Fig. 5: Energy Use in India (Source: World Bank Development Indicator)

7. THE EMPIRICAL INVESTIGATION

When dealing with time series data, the existence of unit root in a time series raises the possibility of spurious regression. So, the first requirement for the time series analysis, the

variables must be stationary. To determine the existence of unit root in the series; we used the ADF test for the individual series in this study. The results show that all the series are non-stationary; while after first differencing, the series become stationary (APPENDIX; 2). Now after making the variables integrated of order 1; the next step is to check the co-integration among the variables; so that we can be ensured about their long run relationship. But before implementing the co-integration test, it is important to determine the lag length for the VAR model; because the Johansen co-integration test is sensitive to changes in lag structure. The application of Akaike Information criteria shows us that the optimum lag is 1 for the regression analysis. After that, the Johansen co-integration test applied to determine the long run relationship among the variables. The results show that both trace statistic and Max-Eigen statistic rejects the null hypothesis of no co-integrating vector at 5% level of significance level. In other words, the result suggests that there exists a long-run relationship between FDI, GDP, CO2 emissions and Energy Use. In the next step, the long run effects of variables are estimated using the DOLS model.

7.1 Regression results

In order to estimate the long run relationship and to avoid the biasness of Ordinary Least Squares (OLS) estimators of the parameters in the co-integrated time series, this study used DOLS method which incorporates contemporaneous values, leads and lags of the difference of the regressors to correct the endogeneity problem and the serial correlation. The results presented in the table III indicates that the variables Net FDI inflows, Energy use are significant at 1% level of significance while the variables of real GDP is significant at 10% level of significance. Moreover, the results also confirmed non-linearity of relationship between real GDP Per Capita and CO2 emission and between Net FDI inflows and CO2 emission. While the long run nexus between Real GDP and CO2 emission is proved to take the shape of U; the long run relationship between net FDI inflows and CO2 emission is found to be inverted U-shaped.

Table III: *Regression results*

Variable	Coefficient	t-statistic
Real GDP	-2.84	-2.29*
Real GDP2	0.20	2.21*
Net FDI inflows	0.62	6.64***
Net FDI inflows2	-0.01	-6.40***
Energy	1.40	6.58***
Constant	-4.9	-1.23
R2	0.99	
Adjusted R2	0.99	
Jarque-Bera	0.55**	

Additionally, Table III presents the impact of energy use on carbon emission; which is also found to be significant at 1% level of significance. The long run emerged to be with the DOLS model. Moreover, the coefficients of lnFDI and lnFDI2 are and respectively-suggesting an inverted U-shaped relationship between Net FDI inflows and CO2 emission; i.e. supports the existence of traditional EKC shape. The results obtained from DOLS indicate that all of the variables of the regression such as FDO inflows, Energy Use, Real GDP per capita as well as their square terms strongly affect carbon emission. It is found from the analysis that per capita income and CO2 emissions does not follow traditional EKC curve; instead it has shown a U-shaped relationship. The plausible reasons for observing such relationship can be cited as follows. India is currently a developing country and in the 1980s India was mostly underdeveloped and primarily based on agriculture. When the major economic activities of a country were primarily based on agriculture sector; then the economic activities did not cause a bad and significant effect on environment. However, when the economy gives more thrust on industrial sector heavily; then the economic activities promote economic growth along with environmental degradation. The industrial sector induced economic growth also accelerates energy use in an economy. In addition, Table III shows that FDI inflows have a strong impact on CO2 emission. However, the findings of this study are not consistent with the findings of some of empirical studies; such as. Contrary to these studies, this study finds that there is a non-linear inverted U shaped long run relationship between CO2 emissions and Net FDI inflows. The explanation for the unique nature of FDI inflows and CO2 emission can be given as follows. At the early stage of foreign investment inflows, most of the underdeveloped countries try to attract funds and foreign investments by relaxing their environmental standards. It results in inflows of foreign funds, rapid industrial expansion and in turn leads to increase in production and energy use or energy consumption. So inflows of foreign investment promotes environmental degradation But after crossing a certain level of threshold, an increase in FDI inflows lead to decrease in CO2 emission as the findings of this study suggest. This may happen because with the increase in global awareness about environment the developing countries feel pressurized and they regulate their environmental regulation towards sustainable growth. Moreover, the technology spill over benefits from developed countries to these developing countries raises efficiency in energy consumption and hence reduces CO2 emission [17].

8. CONCLUSION

Using the data on real GDP per capita, Energy Use, FDI inflow and CO2 emissions in India during 1980-2018; we have examined the impact of growth and FDI inflows on CO2 emissions. Our time series analysis shows us that FDI inflows, Real GDP Per capita did have a positive impact on CO2 emission. Moreover, this study did not find any evidence regarding the existence of EKC shaped relationship between Per Capita income and Environmental degradation. However the empirical investigation suggested an inverted U-shaped relationship between FDI inflows and CO2 emissions for India. To sustain economic growth for future generations, the thrust should be placed on techniques of efficient energy utilisation and renewable energy technologies. In this

process, the FDI inflows can play significant role. To promote environmentally viable growth in India; either stringent command and control approach or policy mix of mandatory and non-mandatory environmental regulation along with economic incentives can be used. But it is generally observed that the regulations with economic incentives can go a long way more effectively to promote sustainable economic activities without harming the willingness and ability of economic agents.

9. APPENDIX

(A). Pearson correlation coefficients for the variables: FDI inflows per capita, CO2 emission, Energy use, Real GDP per capita

	FDI	CO2	GDP	ENERGY
FDI	1			
CO2	0.314*	1		
GDP	-0.015	0.407***	1	
ENERGY	0.041	0.572***	0.443***	1

* indicates 10 per cent level of significance;
***indicates 1 per cent level of significance

(B). Results of unit root test:

Test Statistic	Variables	At level	At first Difference	Conclusion
ADF Test	FDI	-0.92	-6.49***	I(1)
	CO2	-0.27	-6.25***	I(1)
	GDP	3.68	-4.65**	I(1)
	Energy	1.09	-4.36***	I(1)
	FDI2	-0.77	-6.38***	I(1)
	GDP2	4.86	-3.97***	I(1)

*** indicates 1 per cent level of significance

(C). Johansen Co-integration tests:

Hypothesis of Co integration	Trace Statistic	Max-Eigen Statistic
None	101.27*	40.65*
At most 1	60.62	25.56
At most 2	35.06	20.01
At most 3	15.05	10.28
At most 4	4.77	4.74
At most 5	0.033	0.03

Trace test and Max-eigenvalue test indicates 1 Co-integrating equation at the 0.05 level

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